PROLEGOMENON TO EXTENDED MUSICAL INTERFACE WITH THE HUMAN NERVOUS SYSTEM: AN OUTLINE MANDALA OF INSTRUMENTAL, ELECTROCORTICAL FORMS OBSERVABLE THROUGH POINT CONSCIOUSNESS.

dedicated to
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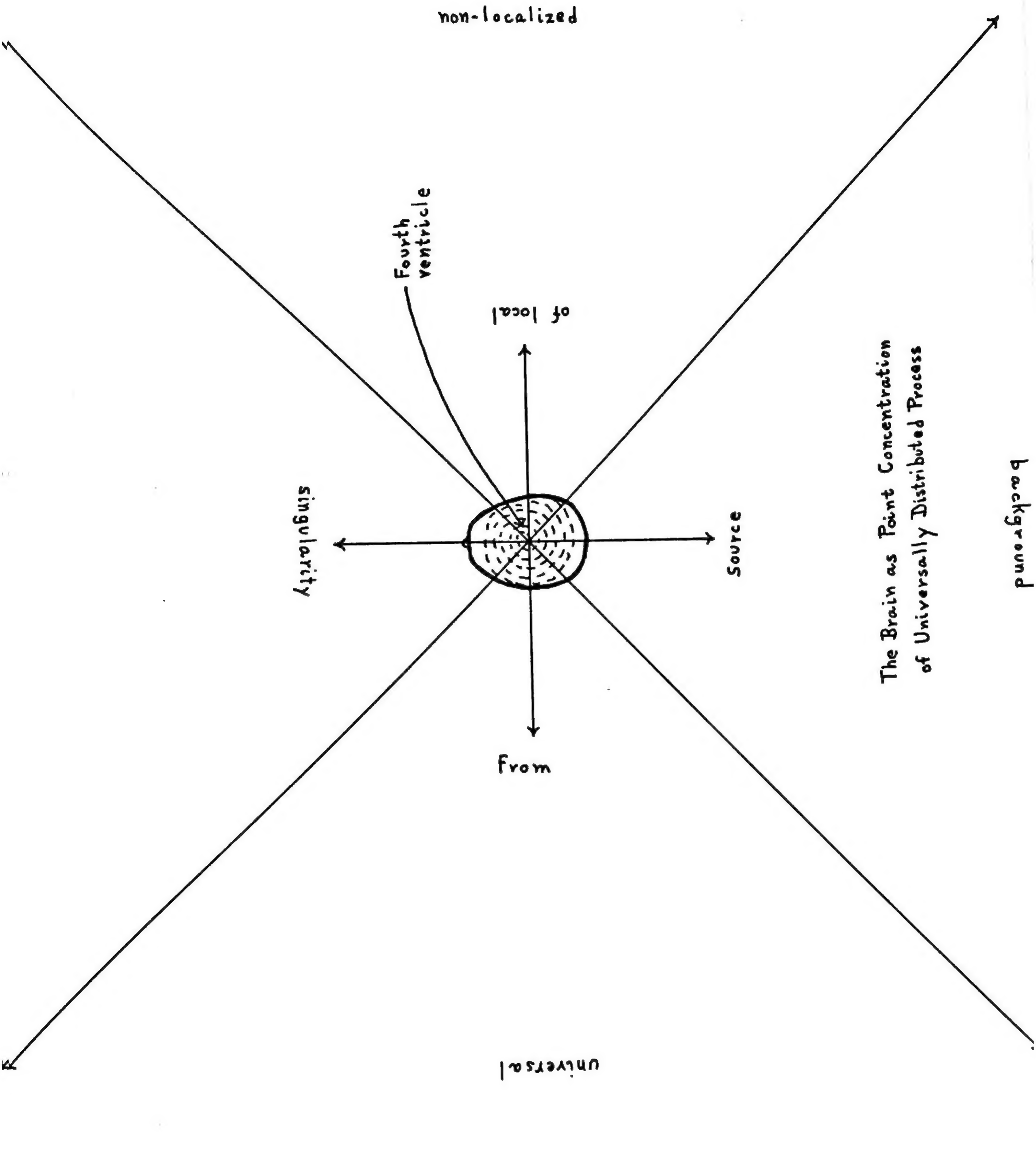
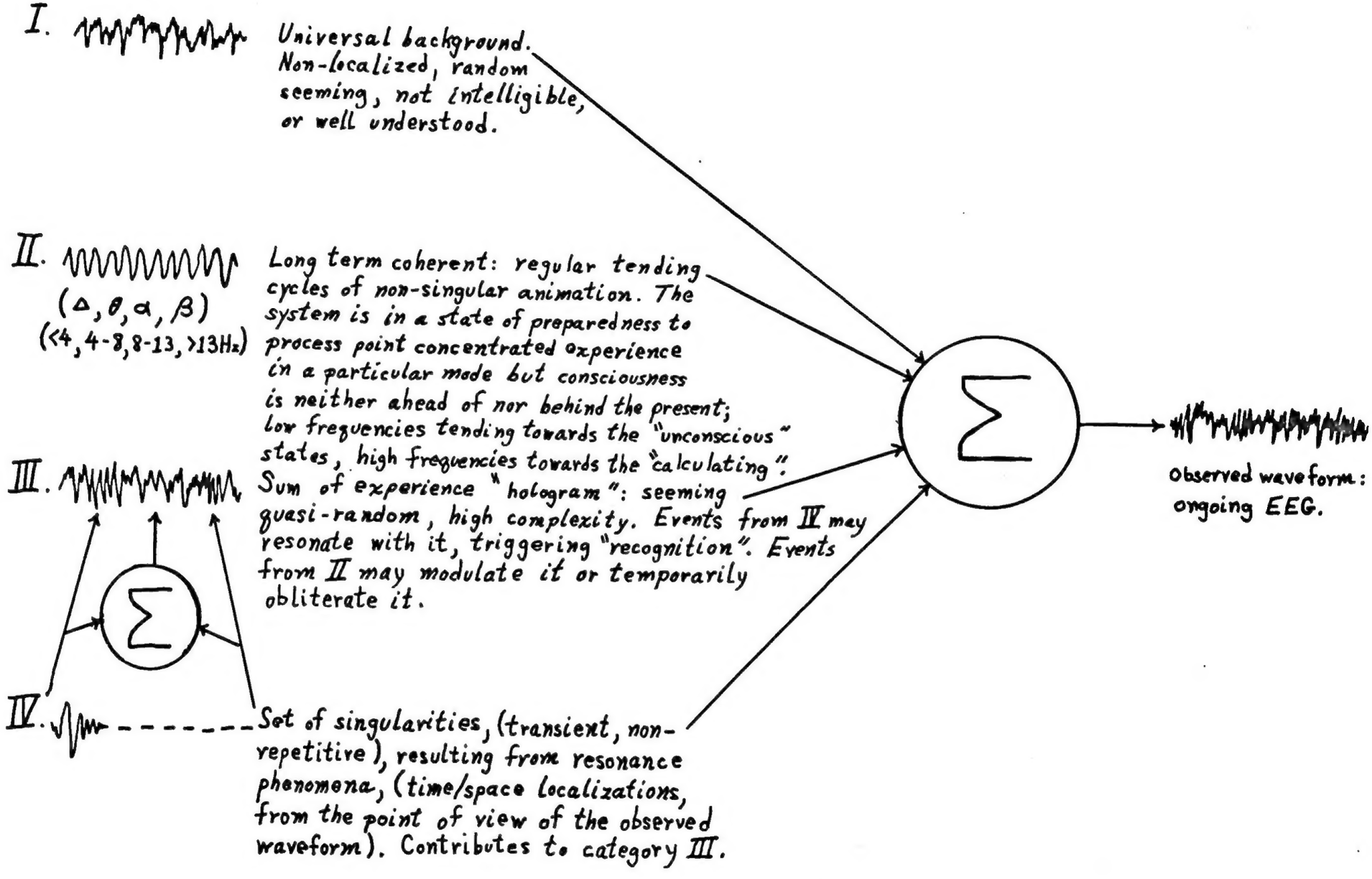
One idea is that of increasing the palette; bringing previously unconscious rhythmic processes into conscious awareness and potential use. The stability of natural oscillators is such that one can submerge him/herself in them and learn the relationship between resonance and the idea of initiating action. These oscillators are plentiful in biological systems and have been well researched. Contained herein is a guide for interpretation of events occuring in the human electroencephalogram, EEG, as they are used in the improvisational composition, ON BEING INVISIBLE, according to musical, psychophysical, and psychophysiological parameters.

During the course of this composition, a computer program condenses the action of many of these phenomena into pattern analysis data that is, in turn, used to control the production musical syntax, realized electronically in real time. Additional macrostructure information is derived from the calculation of plots of relative functioning efficiency of such processes as mental functioning acuity, emotional and intuitive sensitivity, and physical effectiveness. Interactive resonance patterns of such phenomena between human beings can also be derived and utilized.

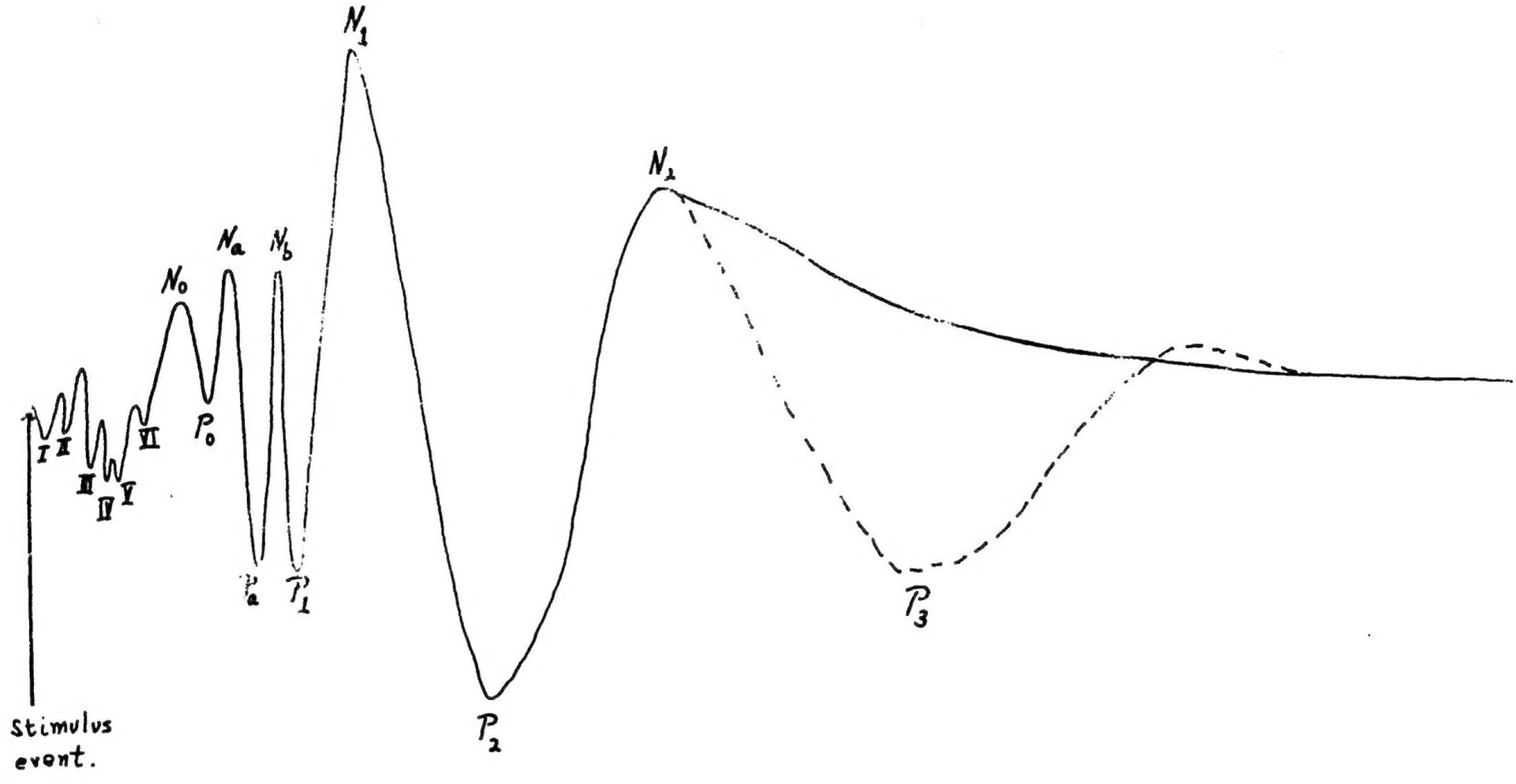
Other macrostructural information is derived from a program that looks for resonance phenomena in a performer's vocal patterns and ongoing EEG. Microstructure information comes from an analysis of physiological performing actions, short-term, transient neural signals, and physiological output codes, termed, "actons".

Thus, natural physical processes, larger than ourselves, influence several levels of the compositional proceedure. The following diagrams constitute the score, in part.

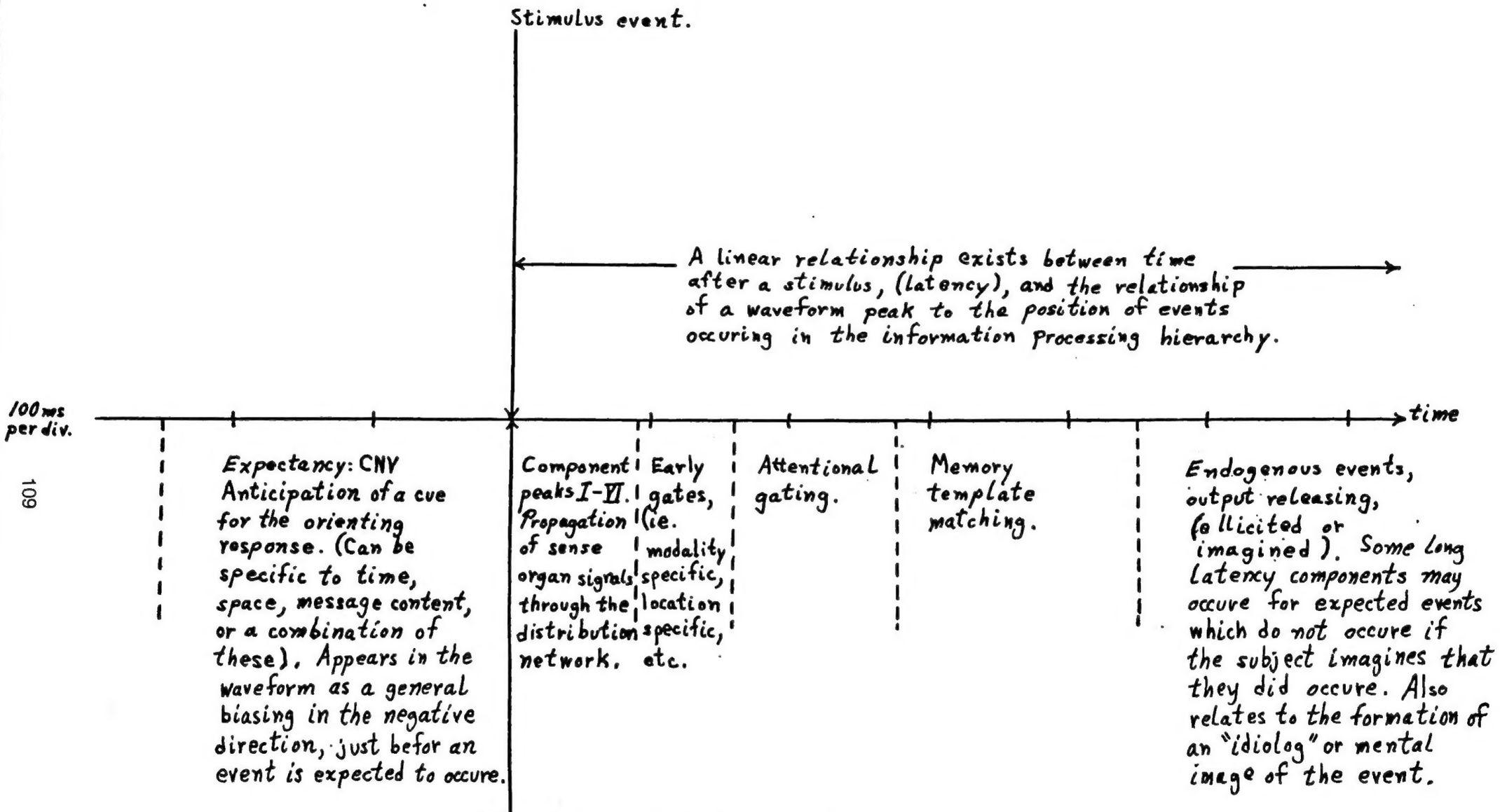

non-localized
Fourth ventricle
of local
singularity
Source
From
universal
The Brain as Point Concentration of Universally Distributed Process
background



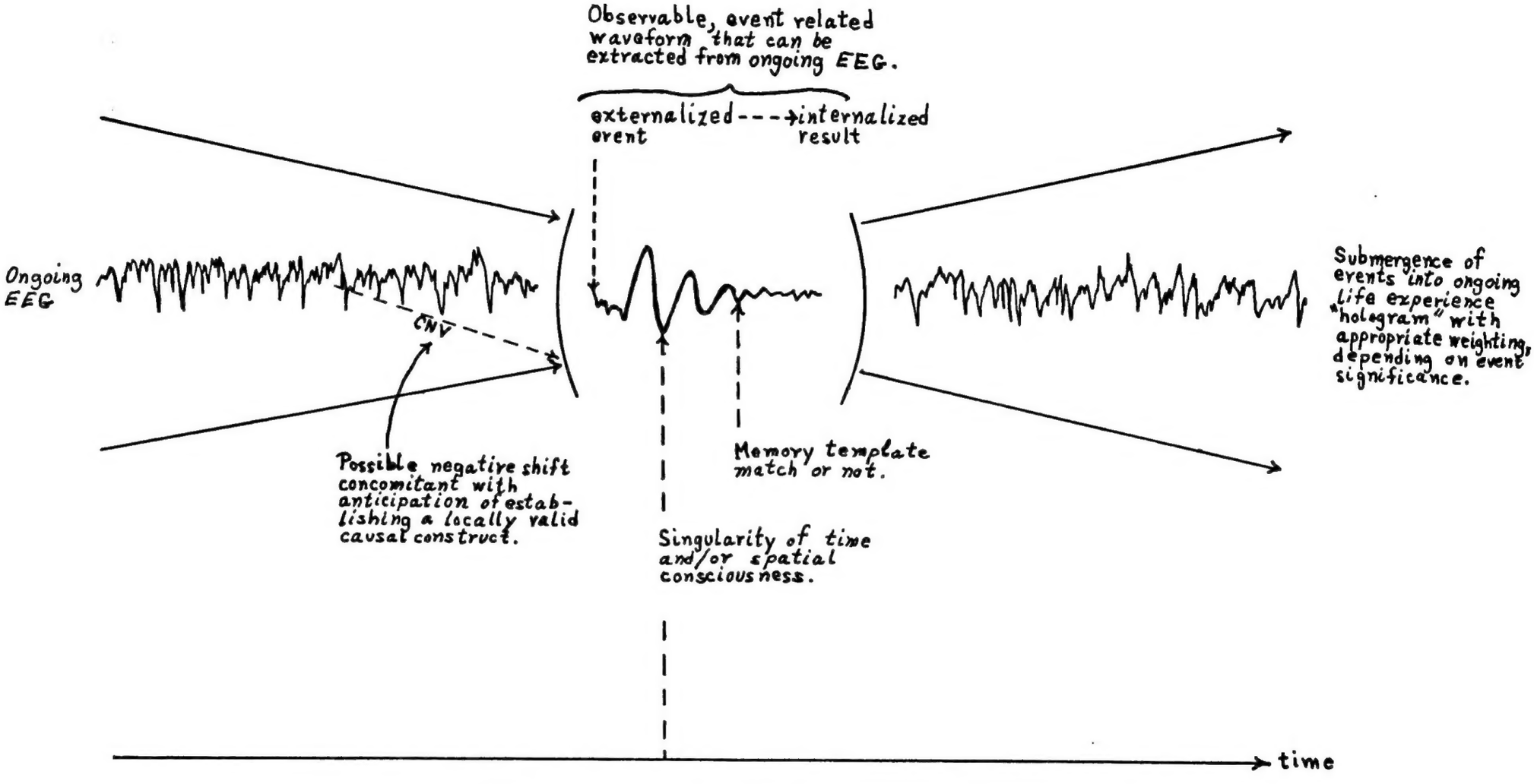
Four broad, formal categories of events contributing to an observed EEG waveform. Events relating to each category can be extracted by various real-time, statistical methods.



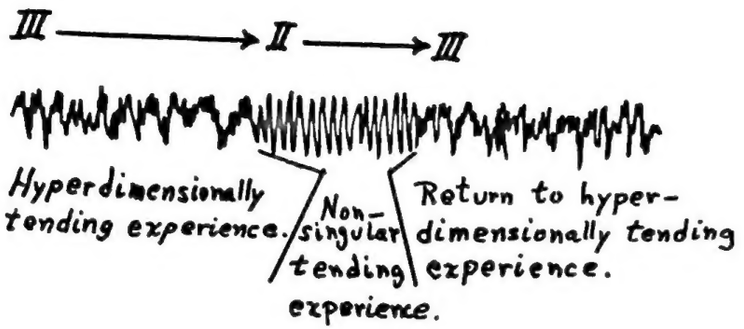
Analysis of detail contained in waveforms from major category. IV. Prototype of untrained, average evoked response, (AER) to a novel, auditory stimulus, (here a 60dbSL monaural click), recorded at the vertex, (top of head). Waveform lasts approximately 750 msec. P_3 may or may not occure and its amplitude is sensitive to the perceiver's higher cognitive processing of the specific stimulus.

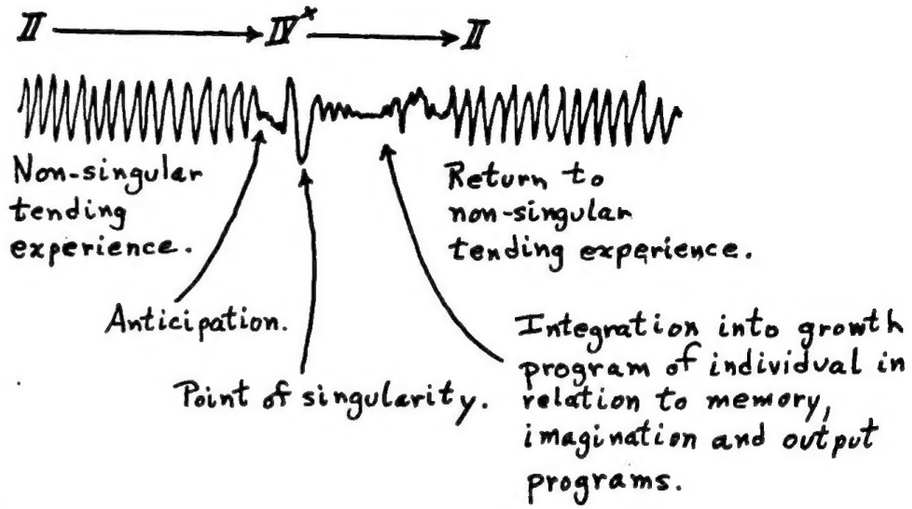


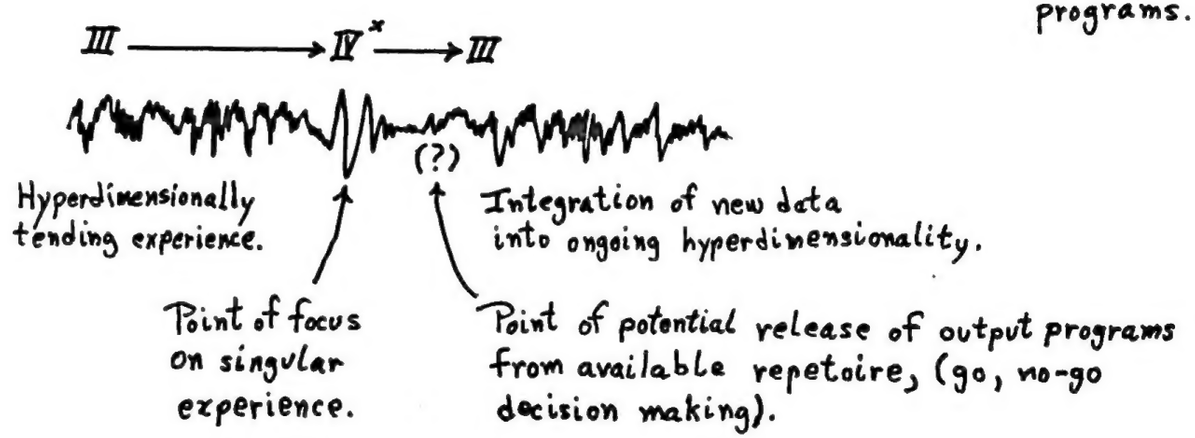
Psychophysiological interpretation of the meaning of waveform peak events in the evoked response shown in the previous diagram.



Visualization of the meaning of locally arrising, transient waveforms from major category IV, in relation to the ongoing EEG. These waveforms are extracted by time locked averaging or correlation methods.







Three sample excerpts from EEG tracings showing transitions between regions of predominance of events from the major formal categories.

*Amplitudes of events from Category IV are shown exagerated for clarity.

NOTES ON INTERPRETATION OF THE SIGNALS

Category I

Very little understood. Look for influence from outer space.

Category II

Coherence and amplitude of signals relates to the number of neurons locking into wide spread cortical synchrony. A continuum of states of consciousness can be observed along the frequency domain ranging from the "unconscious" to the "calculating".

Category III

Pattern analysis is required to reveal salient features that relate to individual experience and programming.

Category IV

Parameters that influence the evoked response.

A. Altered states of consciousness may influence most recordable parameters.

B. Physical aspects of the stimulus.

1. Sound: unidirectional changes of rate of change in amplitude, pitch, timbre, location, and abstract acoustical form. Changes in one parameter tend to mask the effect of changes in another.

2. Vision: unidirectional changes of rate of change in intensity, location, motion speed or direction, color, and abstract form. (Form is a special case in which changes can take place in any or all parameters as a function of of the visual scanning mechanism as well as a function of the stimulus.

C. Cognitive factors.

1. Recognition: positive correlation of input with stored template.

2. Formation of an idiolog or mental image of an event having just occured.

3. Decision making: go or no-go decisions with respect to output programs.

4. Occurance of formal structural landmarks in a stimulus sequence.

5. Characterizations of sentic states observable in EEG or other physiological parameters.

6. Semantic meaning of the stimulus.

D. Psychological factors.

1. When an unconditioned stimulus becomes a conditioned stimulus, a new, late component appears in the evoked response, (P_3).

2. Selective attention: N_1 and P_2 are large for stimuli that are attended to.

3. Relevance of stimulus to subject or to task at hand.

4. Sensitivity: (measured by standard d' technique). P_3 is large for stimuli for which d' is high. Note: Sensitivity may be altered by feedback, facilitating an heuristic process in which pattern perception is altered.

5. Expectancy: Anticipation of a cue for the orienting response. Expectancy may be of what or when or where or a combination of these and may influence sensitivity. It is seen preceeding the evoked response in a contingent negative variation, CNV. It is different in situations where a physical response to a stimulus may be required. Endogenous evoked responses may appear at the time expected but absent stimuli are expected to occure and resemble evoked responses to the coresponding physical stimuli.

E. Information value of the stimulus.

1. There is a monotonic relationship between the size of an evoked response to a particular stimulus and the informedness of that stimulus until information saturation is reached and the function levels off.

2. Evoked responses are large if one or more stimulus parameters are out of the range of comonly present environmental stimuli.

F. A linear relationship exists between time after a stimulus and the relationship of an evoked response peak to the position of its associated cortical events in the information processing hierarchy. Early components relate to primary processing while later components relate to higher mental functions.

1. Spatial location of an energy source occures early.

2. Propagation of sensory signals through the distribution network occures early.

3. Signal classification, memory correlation, readout of endogenous or imagined events occure later, for instance.

4. N_2 relates to sensory gating and is channel specific.

5. P_3 is message specific and is sensitive to a particular stimulus within a relevant sensory modality.

G. The system is bilateral.

1. Left hemispheric events represent analytic events or positional visual processing.

2. Right hemispheric events represent holistic events or apositional visual processing.

H. Readout components

1. Late evoked response components may arrise from endogenous sources, from memory, or from imagination.

2. Physiological output code signatures may be recorded from EEG or muscle signals and are termed, "actons". They are specific to particular expressions of sentic states.

For a detailed discussion of the research background of these ideas, please consult:

Rosenboom, D. (ed.): Biofeedback and the Arts: Results of Early Experiments, Aesthetic Reseach Centre of Canada, P.O. Box 3044, Vancouver, British Columbia, Canada, V6B 3X5.